Prediction of strong ground motions from huge subduction earthquakes in the period range from 1-5 seconds

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In the past study of strong ground motions from shallow crustal earthquakes such as the 1995 Hyogo-ken Nanbu earthquake and the 1994 Northridge earthquake, strong emphasis was placed on the importance of pulse-like ground motions generated from asperities (e.g., Irikura, 1996; Koketsu, 1996). On the other hand, in the study of strong ground motions from subduction earthquakes, pulse-like ground motions have attracted less attention of researchers. During the 2003 Tokachi-oki earthquake and the 1978 Miyagi-ken Oki earthquake, however, which are subduction earthquakes, strong pulse-like ground motions were observed at many strong motions stations. A typical example can be found in the record at KiK-net station TKCH07 during the 2003 Tokachi-oki earthquake (Mw8.0). The shape and the period of the pulse included in the record were quite similar to those in the record at Sylmar County Hospital during the 1994 Northridge earthquake (Mw6.7) (See Figure), indicating that the size of the primary asperity for the Tokachi-oki earthquake does not differ significantly from that of for the Northridge earthquake, in spite of the difference of the earthquake. Another feature of the strong ground motions from the 2003 Tokachi-oki earthquake is the large diversity of the type of ground motions, from a pulse-like motion to a long-lasting cyclic motion. Based on the analysis on the Fourier phase of the mainshock and the aftershocks, it can be estimated that the diversity mainly comes from the site effects, not from the complexity of the rupture process in the mainshock. Based on these observations, the author recommends the following.

1) To evaluate strong ground motions from a subduction earthquake in the period range from 1 to 5 seconds, a characterized source model be used, in which the size of the asperities are determined so as to be consistent with the width of the pulses observed during the past subduction earthquakes with a relevant size.

2) To calculate strong ground motions in the period range from 1 to 5 seconds, the method based on empirical site amplification and phase characteristics (Kowada, 1998; Nozu and Sugano, 2008) be used to express the diversity of the ground motions appropriately.